PEACH YELLOWS AND LITTLE PEACH[1]

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(WITH PLATES VI, VII)

Peach yellows and little peach are well known but poorly understood diseases, and have been the subject of study by many workers for a number of years. Although they have engaged the efforts of some of our most efficient workers, the causes are as yet unknown, the symptoms not well defined from similar symptoms due to some other common causes, and the methods of control are very unsatisfactory. Although the researches have been directed along many lines, very little attention has been given to the morphology of the organs of the infected plants as compared with the morphology of corresponding organs on healthy trees. The fact that a knowledge of the morphology is frequently a very important factor for physiological studies has led to the preparation of this paper, hoping that the accumulation of data along various lines may eventually assist some student to solve this problem.

The material used was taken from trees in an experimental orchard at Vineland, New Jersey, which was planted and managed by the Department of Horticulture of the New Jersey Agricultural Experimental Station. The trees were under constant observation, and there was no doubt as to their condition. The material was carefully collected during the early morning and mid-afternoon of a bright warm day in midsummer, when the conditions were exceptionally favorable for growth. Care was taken to select leaves of approximately the same age, and the same precaution was taken with the twigs. A great many sections were cut and a considerable number of drawings made, from which the figures shown in the plates were selected.

The studies were based on a comparison of the structure of corresponding parts, the relative amounts of starch in these organs morning and afternoon, and its relative location. The studies of

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structure did not show any differences of importance, and will not receive further consideration at this time. The study, however, of the amount and location of the starch within the tissues of the leaves and green shoots gave some interesting data, and therefore the basis of the work is a comparative study of the results of photosynthesis and translocation of carbohydrates in healthy and diseased trees.

Before considering this phase of the work, the generally recognized symptoms of these diseases are indicated, since they must be referred to from time to time. The first symptom in both cases is an infolding along the midrib or rolling of the margins, accompanied by a pronounced backward curving from base to tip so as to give a sickle or crescent effect, and the development of a decidedly leathery texture which is very apparent to the touch. The second symptom for yellows is the development of enlarged, prematurely ripened fruits, which show a characteristic red spotting or blotching over the surface and through the flesh, especially prominent near the stone. The final stage in the yellows is the development of fascicled, willowy shoots. Very similar symptoms may be produced by partial or complete girdling of trunk or branch by winter injury at the collar, by borers, by label wires, or other factors. There is no doubt that many of the reported cases of peach yellows in the past were in reality cases in which the symptoms were produced by some of these causes. The first stage or leaf characters in little peach is similar to that of yellows, but is very likely to be more pronounced than in yellows. In the second stage the fruit is small and ripens later than in the normal healthy trees. There is no willowy growth as in the case of yellows. The symptoms just described are subject to many variations, dependent upon cultivation, care, and other factors. Yellow foliage may be due to many other causes, and is not necessarily a symptom of yellows. In fact, trees infected with this disease may be very green, especially if fed with a fertilizer high in nitrogen. Trees infected with yellows will sometimes persist for a number of years, but those infected with little peach usually die in a comparatively short time.

In a normal healthy plant the starch content is expected to be much greater in the afternoon than in the early morning, due to the high photosynthetic activity during the day and the lack of photosynthesis and a very active translocation of starch during the hours of darkness. In this work a study of the sections of leaves from healthy trees removed early in the morning and in mid-afternoon was made for comparison with leaves from diseased trees which were collected at the same time. In the leaves from normal healthy trees it was found that there was very little or no starch in the leaves during the morning hours, and an abundance during the afternoon (figs. 1, 2.) This of course was to be expected, and indicated that the photosynthetic and translocation processes were normal and active on the day that the material was collected. In some instances a small amount of starch was found in the cells in the morning in the immediate vicinity of the veins (figs. 3, 4). This was no doubt due to incomplete translocation and may possibly indicate a slightly abnormal condition.

Leaves were collected from the varieties known as Stump, Hiley, and Chinese cling, which were affected with yellows. In those in which the disease was severe, the amount of starch in the sections from leaves cut in the morning was almost as great as the amount found in leaves cut in the afternoon, indicating little or no translocation of the carbohydrates (figs. 5, 6). The amount of starch, however, was not as great in either case as in the healthy Elberta (fig. 2) in the afternoon, but was greater than in the healthy Hiley (fig. 4). These differences in the amount of starch in the individual trees may be due to a difference in the physiological activities of the trees, and may possibly be accounted for by differences in variety, age, or other factors.

A morning section of a Chinese cling affected with yellows (fig. 7) compared with a morning section of a healthy tree of the same variety showed a much larger amount of starch in the leaf from the diseased tree than in the leaf from the healthy tree, indicating not only a reduced translocation of carbohydrates but also an accumulation of these products. There was very little difference, however, between the amount of carbohydrates found in the morning and afternoon sections from diseased trees (figs. 7, 8).

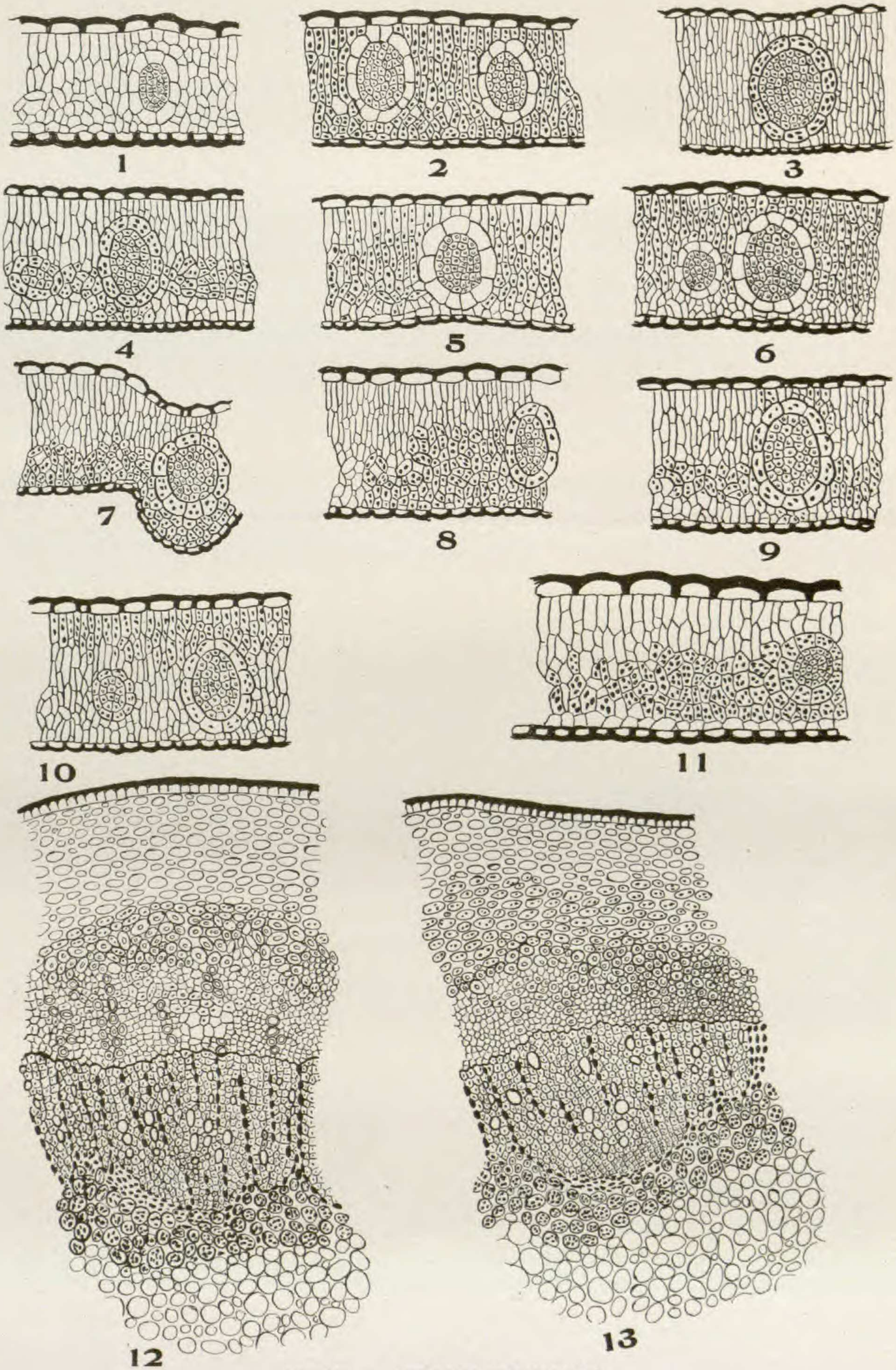
The little peach was studied on Elberta and Hiley. The amount of starch was practically the same in the sections from leaves collected in the morning as in the afternoon (figs. 9, 10), but was less than in the trees affected with yellows (figs. 5, 6). In some other sections, however, the amount of carbohydrates in both morning and afternoon sections was greater than that shown in figs. 9 and 10. The starch in the sections from leaves cut in the morning was most abundant in the central part of the leaf (fig. 9), and may indicate some translocation. A morning section of leaf from Elberta infected with little peach (fig. 11) showed a large amount of starch, indicating that very little translocation of starch had taken place during the preceding night.

Pieces of new growth shoots were collected at the same time that the leaves and sections from Elberta, Stump, Hiley, and Chinese cling were studied. The results were practically the same throughout, but as the material from the Hiley was most abundant and most satisfactory it is used for this part of the discussion. A comparison of morning and afternoon sections of young shoots from a healthy tree shows a considerable amount of starch in the inner layers of cortex in the afternoon section (fig. 13) and very little in the morning section (fig. 12), indicating normal translocation of carbohydrates. These twigs were from the same tree as the leaves in figs. 3 and 4. The shoot from the tree affected with yellows (figs. 14, 15) was slightly older than the healthy shoot. The amount in the morning and afternoon was practically the same, indicating that there was little or no translocation of carbohydrates. These twigs were from the same tree as the leaves shown in figs. 5 and 6. The sections from the tree affected with little peach showed a slightly smaller amount of starch in the morning (fig. 16) than in the afternoon (fig. 17), which may possibly indicate that there was a small amount of translocation. These twigs were from the same tree as the leaves in figs. 9 and 10.

It will readily be seen that all these studies on both the leaves and the new growths indicate that the translocation of starch is partly or completely inhibited in the diseased trees, probably dependent upon the severity of the disease. This is indicated by the large amount of starch present in leaves and green twigs from diseased trees in the early morning, as compared with the relatively small amounts in leaves and green twigs from healthy trees at the same hour. It is very generally recognized that girdling interferes with the translocation of carbohydrates, and as a result thereof bearing plants very frequently produce extra large fruits which usually ripen prematurely. The production of large premature fruits is also a characteristic symptom of yellows, and it therefore appears that the physiological behavior of a tree affected with yellows is the same or very similar (so far as photosynthesis and translocation of carbohydrates are concerned) as in a tree that has been girdled. In trees affected with little peach, however, the symptoms, so far as the fruit is concerned, are just the reverse, the fruit being somewhat smaller and ripening later than normally. This may possibly account for the fact that sections of twigs from trees affected with little peach showed some evidence of translocation of starch, while those from trees affected with yellows did not show any such evidence. These differences, however, may have been due to other causes, such as severity of infection, age of trees, or other factors.

The preceding discussion indicates that the translocation of starch is greatly reduced, possibly completely checked, in trees affected with either of these diseases; or that have been girdled and injured by label wires, bores, or at the collar as a result of freezing. In all cases the results are an accumulation of starch in the leaves, which may account for the leathery texture, but does not offer an explanation of the willowy growth of the final stage of the yellows. If the translocation of carbohydrates is reduced or prevented, however, it may have a secondary effect on the tree, resulting in the willowy growth.

Furthermore, the reduction or inhibition of the translocation of carbohydrates may also account for the enlarged premature fruit which is characteristic of trees affected with yellows, or that have been girdled, but it does not explain the undersized fruit and delayed ripening which is characteristic of trees affected with little peach. These facts indicate that some of the symptoms of these diseases are due to reduced or inhibited translocation of carbohydrates. The cause of this condition is a question that remains unanswered.



COOK on PEACH DISEASES